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GENERAL REVIEWS AND SUMMARIES

RECENT LITERATURE OF A GENERAL NATURE ON ANIMAL BEHAVIOR

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Summaries of Behavior Literature.—The object of practically all recent text-books of animal behavior has been either the detailed presentation of the results in some limited field or the concise definition of the general problems of behavior, with experimental work presented only as illustrative material. Kafka's Introduction to Animal Psychology has a somewhat more ambitious program in attempting to review in some detail the work in all fields of behavior. The first volume (7), which is devoted primarily to the sensory equipment of invertebrates, offers the most extensive treatment of this field that has yet appeared. It is divided into eight sections dealing with the tactile, static, auditory, temperature, chemical, light, spacial, and temporal senses, each carried through the phylogenetic series of invertebrates. Extensive descriptions and figures of sensory mechanisms are included with discussions of the experiments bearing upon their functioning. While this is the primary subject of the book, it involves the presentation of the simpler action systems and types of reaction. The arrangement of the book does not permit of systematic treatment of the latter or of the general problems of differential sensibility, tropisms and orientation, modifiability of behavior, etc., but brief discussions of these are scattered through the different sections under the descriptions of the organisms which have contributed most to the solution of the problems. In general the author tends to avoid the extreme

simplification in theories of reactions which has been introduced by Loeb and his followers. The more complex activities of invertebrates, instincts and habit, are reserved for the second volume of the work. In this the author proposes to deal with the senses of vertebrates and with the more general problems of behavior. The value of the present volume is chiefly as a summary of recent experimental literature and in this respect it is certainly the most thorough and comprehensive general work which is available. When supplemented by a more systematic treatment of the problems of behavior such as the author, perhaps, intends the second volume to be, the book should prove invaluable as a means of orientation in the literature of behavior.

Of scarcely less importance for students of invertebrate behavior is Jordan's Comparative Physiology of Invertebrates (6). Only one volume of this series has appeared, that dealing with nutrition. A good bit of behavior material connected with food taking is included in this and the close relation of the problems of behavior and metabolism in the lower invertebrates gives interest to the remainder of the volume. Like Kafka's book, this is almost encyclopedic in size and scope (760 pages) and a brief review of its contents must be quite inadequate. The introduction of the book is devoted to the chemistry of foods and digestion. This is followed by chapters dealing with each of the invertebrate phyla and summarizing the chief experimental work upon food taking, digestion, assimilation, and excretion.

The appearance of the ninth volume of the fourth edition of Brehm's *Tierleben* (18) completes the section devoted to birds, which has been revised chiefly by Marshall. The new edition has been modified considerably from the earlier ones. A complete rearrangement of the material in correspondence with present ideas of genetic relationships has led to the emphasizing of this phase of the revision with the insertion of a considerable amount of systematic material. An attempt has been made to bring the discussions of behavior into accord with newer ideals in animal psychology but the anecdotal method of Brehm has not lent itself well to such treatment. This is particularly true of the volumes on birds, the earlier editions of which contain a large amount of behavior material. Something of the readableness of the books has been sacrificed in the attempt to avoid anthromorphic terminology, without the compensation of an increased insight into behavior mechanisms. "Die Papageien sind befiederte Affen," says Brehm in the second

edition. The omission of such picturesque expressions seems a needless sacrifice in a book of this character.

One volume dealing with Mammals (Bd. X), revised by L. Heck, has appeared. It is devoted chiefly to monotremes, marsupials, and insectivora and contains a large and valuable amount of new material dealing with the habits of these mostly rare and primitive forms. The volumes dealing with the amphibia and reptilia (Bd. IV–V) have been greatly extended, from 673 to 1,170 pages, by the addition of new material which is very largely made up of studies of behavior.

The extensive investigations of Pawlow and his students, most of which have been reported in Russian, are not readily available and the review of this work by Mme. Dontchef-Dezeuze (2) is most welcome at this time. The first section of her book is devoted to a description of the method of Pawlow, which has already been made familiar to American readers by the review of Yerkes and Morgulis.[1] Pawlow's new laboratory near Nevka is described briefly. In it the arrangements are so made that the animals may be kept in absolute isolation in sound-proof rooms under uniform conditions of light and temperature. An improvement in the method of collecting the saliva makes it possible for the experimenter to watch the reactions while in a room completely separated from the animal. A somewhat uncritical review of the results obtained by the salivary reflex method follows this description. No adequate description of the technique of stimulation is given and no consideration of the errors to which the method is subject. The experiments of Biélakov showing a sensitivity to a difference of $\frac{1}{8}$ tone in the dog are reviewed in detail, as are the studies of Orbeli on visual, and Kasherininova upon the tactile sense in the dog. Some recent experiments by Bohn upon the "transformation of stimuli" are recorded for the first time. Bohn subjected dogs to an electric shock and obtained an association of this with food. As soon as the conditioned reflex was established the electric stimulus had no further effect than the production of a flow of saliva, although it had at first been followed by violent avoiding reactions. The extirpation experiments of Toropov are reviewed at some length, the general conclusion being in support of localization of sensory function, at least as concerns the perception of form. A chapter is devoted to the experiments upon the extinction of the conditioned reflex by repetition of the stimulus, to its inhibition by

[1] This BULLETIN, 1909.

other stimuli and to its reappearance after the dying out of the effects of inhibition or after "inhibition of the inhibitors." In view of the fact that experimenters employing other methods have not been able to verify the results obtained from the study of the salivary reflex either in the field of audition or in that of cerebral localization, and that the salivary reflex is, at best, somewhat evanescent, it is unfortunate that Dontchef-Dezeuze has not given more attention to the technique of the Russian school. She seems to imply that the ideal methods of Pawlow's new laboratory were employed in the experiments reported, whereas in much of the work the methods of stimulation were crude and the possibility of the animal's reacting to "cues" other than the intended stimulus was not rigidly eliminated. The second half of the book of Dontchef-Dezeuze is devoted to a correlation of the physiological results of Pawlow with the phenomena of imagery in man.

The More Complex Behavior of Animals.—In the introduction to the volume reviewed above, reprinted in a somewhat extended form (**8**), Kafka discusses the interpretation of animal behavior. He supports the argument from analogy for consciousness in animals but points out the failure of the objective tests for consciousness of Loeb and Bethe, the presence of "associative memory," and of Driesch's argument for a non-material agent in behavior from the "individuality of correspondence" between stimulus and response.

De Lanessau (**10**) gives a brief summary of the conception of the intellectual and moral faculties of animals and man which was advanced by Buffon. Buffon followed Descartes in denying a soul to the animal and developed somewhat the latter's mechanical explanation of animal behavior. He recognized many involuntary movements in man (reflexes) and their dependence upon stimulation. He held that volition is the result of similar stimulation and described the balancing of motives as a purely mechanical process. His system of ethics is a consequence of this attitude for, while he ascribed a soul to man, "he appeared, even when he affirmed his belief in a divinity and in the human soul, to wish to inspire his hearers with the conviction that both are absolutely useless."

Hachet-Souplet (**3**) attempts an extensive comparison of the more complex activities of animals with those of the human infant. The point of view of the author is primarily educational and much space is given to the description of methods of training and the similarity of methods of learning in animals and in the infant.

The mental activities of the child have been chosen as a basis for the comparison rather than the behavior of the animal and in consequence there is an attempt to find in the animal analogies for the higher intellectual processes for which there is as yet no experimental or observational justification. The chapters dealing with the animal's conception of causality and of his physical ego, with his processes of abstraction and his æsthetic tastes are characterized by sweeping conclusions based upon wholly inadequate experiments, thus: "A dog is seated upon a bench. I call, 'Here.' He comes immediately. Six dogs are on the same bench, among them the first. Again I call, 'Here,' in the same tone as before. Not one of them moves. They wait until I call 'Dick,' 'Tom,' or 'Pompon.' They know that there are other dogs than themselves, and this seems to prove that they have a clear idea of their physical personality." Many experiments are described in which the most elementary precautions were omitted and from the results of these a high degree of intellectual development in animals is deduced. The chapter upon the laws of association lays a much needed emphasis upon the "law of recurrence," the progressive fixation of sensory impressions in the inverse order from that in which they are experienced. The section devoted to the infant is concerned chiefly with a comparison of the methods of training and teaching, and to tracing the development of the child's ideas, particularly in matters of ethics, to the influence of environment.

In a brief communication Pfungst (11) outlines his work with a variety of apes, carried out chiefly at the Berlin Zoological Garden. He was able to observe the development of six individuals from infancy and found no evidence that any of the young received instruction from the mother or profited greatly by imitation. He found that they did not imitate the trainer at all. There was no prevailing use of either hand in some hundreds of animals which he examined, except in a few cases which were found to be pathological. Some observations were made upon the expression of the emotions. A playful showing of the teeth, analogous to the human smile, is a sign of friendliness as is the turning of the posterior part of the body. In general Pfungst finds that the apes are capable of more ready and complex habit formation than lower orders of animals but finds no evidence that they are able to make generalizations.

As a book written by a lover of animals for animal lovers Unruh's *Leben mit Tieren* (15) offers many interesting points. It consists

almost exclusively of the author's reminiscences of his own horses and dogs with casual observations upon other domestic animals. The experimental method is criticized as unsympathetic and hence lacking in understanding of the animal. The interest of such a volume lies fully as much in the personality of its author as in the thesis of the book itself and in his anecdotes Unruh provides enough personal data to give some insight into the development of his attitude toward his animal friends.

Under the somewhat comprehensive title of *Beiträge zur modernen Tierpsychologie* Dexler (1) gives a severe criticism of Krall's *Denkende Tiere*. The greater part of the book is dismissed as belonging to the region of the miraculous and the critic contents himself with an examination of Krall's tests of his animal's sensory equipment. He finds the experiments wholly inadequate for the purpose for which they were devised, the exclusion of possible "cues" which might influence the horses' replies to questions.

Haenel (4) points out many sins of omission and commission in Dexler's review but scarcely answers the criticism of Krall's sensory physiology.

The great mass of literature dealing with the horses of Elberfeld has inspired the launching of a new journal under the editorship of Karl Krall (9). The program of the journal includes the publication of articles upon anatomy and physiology, accredited observations upon the mental life of animals, reviews of behavior literature, and articles dealing with human conceptions of the animal and with the part played by these in folklore and popular literature. The first numbers are devoted largely to discussions of the horses of Elberfeld and similar animals. Whatever may be the ultimate fate of these animal prodigies the journal promises much of value in the last article of its program and in its editor's policy of reprinting old and rare discussions of animal intelligence.

Literature of General Biological Significance.—Yerkes (16) reports the results of a preliminary study of the inheritance of wildness, savageness, and timidity in rats. Wild rats and hooded rats of two different strains were employed. The characters proved to be definitely heritable entities and the degree to which they were developed was found to be roughly proportional to the amount of wild blood present in the different strains. This is almost the first attempt by a trained psychologist to apply to animal behavior the facts and theories so rapidly accumulating in the field of genetics. Chauvin, Schroeder, Kammerer, and Haecker

have accumulated a small amount of evidence upon the inheritance of variations in instincts but the interests of these investigators are primarily in the inheritance of acquired characters and their studies of behavior are not always above criticism.

As yet the study of animal behavior has received far more than it has given to other branches of biological science but it is rapidly coming to a place where it can return all that it has borrowed. The field in which it can, at present, contribute most to the general theories of biology is probably that of organic selection, for the solution of whose problems a knowledge of the sensory equipment of animals is essential. Some of the most striking problems of evolution are presented in the facts of sexual dimorphism. Pycroft (12) has collected a large amount of material upon this subject and his book is particularly rich in its descriptions of the behavior differences between the sexes. In his explanation of these differences Pycroft follows Wallace, substituting the secretion of hormones for Wallace's theory of the excessive energy of the male, and emphasizing particularly the indifference of variations in the characters with respect to preference on the part of the undifferentiated mate. Only one experiment upon the problem of sexual selection is given, that of Mayer upon the moth. Indeed, practically all the theories to account for sexual dimorphism have been unsupported by experimental evidence for or against sexual selection and the experimental work is restricted entirely to arthropods. There is great need for a study of the problem in vertebrates and Pycroft's book will furnish an excellent starting point for such work.

Slonaker (14) studied the total amount of activity of the albino rat from birth to death by means of specially devised apparatus. This consisted of a cylindrical cage, revolving about a stationary axle upon which were placed the food and nest boxes, and of apparatus which recorded the number and temporal position of the revolutions of the cage. Records of all movements of the animals outside the nest boxes were thus obtained. It was found that during the first six months of life the activity of the albino rat is distributed irregularly throughout the day and night. From the sixth to the twenty-fifth month the greater part of the activity is confined to the hours between 3 p. m. and 3 a. m. With the beginning of senility at twenty-one to twenty-five months the rat's activity decreases greatly and nocturnal running, which during the prime of life sometimes amounts to as much as 14 miles per day, almost disappears. The greatest amount of activity occurs in

males at the age of ten months and in females at the age of twelve months and the total amount of activity of the females during their lifetime is about three times as great as that of the males. Almost three-fourths of the total amount of activity appears during the first half of the rat's life. A group of unexercised rats was kept as a control upon those in the revolving cages. They became heavier and showed an average longer life than those which were able to run freely.

Rothmann (13) removed the cerebrum of a dog, leaving the optic tracts intact, together with a small amount of the basal portion of the cerebrum which could not be removed without destroying the optic chiasma. The dog was kept alive for three years at the end of which time the report was made. Three days after the operation the animal could walk a little and soon recovered the ability to run and jump. He retained sensitivity to pain and heavy pressure (these were not localized), to kinæsthesia, and to taste. Many of the higher reflexes were retained or reestablished. In food taking at first only the sucking reflex was retained but later mastication was restored and the dog ate if his nose were placed in contact with food. He distinguished between food and moist sand. Rothmann suggests that the regions of the oral sense of Edinger may not have been destroyed. Periods of sleep and waking were normal. The dog learned to inhibit movement when brought against an obstruction, to leap a hurdle, elevating his hind legs to a height equal to that determined by his fore legs, and to walk upon his hind legs when his fore feet were placed upon a stool and the latter was drawn across the floor.

Definitions.—Huxley (5) devotes a small volume to the discussion of the problem of individuality in animals. For him the mark of individuality is the degree of independence of environmental fluctuations attained. This is brought about first by the specialization of parts, the organization of the living being. It is made more perfect by increase in size, by further differentiation, and by increase in adaptability. After the development of this conception the author goes on to show the application of it to different types of organisms, the method employed by various organisms to attain a greater degree of individuality and the diverse ways in which it is manifest.

Yerkes (17) suggests some changes in the terminology of animal psychology, chiefly the divorcing of the expression "comparative psychology" from its common usage as a substitute for "animal

psychology" and its application in a logical sense to any psychological studies employing the comparative method. He also insists that the student of behavior is quite unjustified in his application of the term psychology to behavior material. If this latter view is accepted it surely means that a science of "animal psychology" is impossible.

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RECENT LITERATURE ON TROPISMS AND INSTINCTIVE ACTIVITIES

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Tropisms

Chemotropism.—By placing a few drops of a chemical in the water that contained leeches, Gee (**12**) discovered that, for each chemical, there is a certain strength above which the leeches exhibit pronounced negative chemotaxis and below which they are indifferent. For nitric acid this is 1/80 per cent.; for copper sulphate, 1/320 per cent.; for sodium chloride, 1/5 per cent. Cane sugar, up to 5 per cent., induced no chemotactic response. Evidently, in leeches injurious chemicals induce negative chemotaxis.

Geotropism.—Gee (**12**) found that leeches are normally positively geotactic, but that the blood leech, when kept in an aquarium, is indifferently geotactic.

Weiss (**26**) placed a glass cage containing hibernating specimens of the "lace bug" (*Corythuca ciliata* Say) in a warm room. On awakening, these bugs climbed upwards, one over the other, until there was a column several bugs high. Usually, when the tower was six bugs high it swayed and toppled. When the temperature was sufficiently high, this negative geotropism occurred in both light and darkness.

This same investigator deprived certain beetles (*Adalia bipunctata*, *Coccinella 9-notata*, and *Megilla fuscilabris*) of food for a short while and then placed them at the foot of a vertical rod 15 feet high. Negative geotropism caused them to climb up the rod for seven to nine feet. The ascension occurred in both sunshine and shadow.

Phototropism.—According to Gee (**12**), leeches exhibit marked negative phototaxis.

Torrey and Hays (**24**) find that, correlated with its nocturnal habits, the sow bug (*Porcellio scaber*) is negatively phototropic. By manipulating a light in its rear, it is possible to guide the crustacean in circles or spirals, at the will of the investigator. A perpendicular beam of light flashed on the side of a leech moving away from a light in the rear almost invariably caused it to move away from the lateral glare. This was true whether the light in the

rear was extinguished or allowed to shine. Extinguishing the light in the rear and simultaneously flashing one in front caused *Porcellio* to move away from the new light. When both eyes were blinded with a mixture of charcoal and glue, there were no responses to light. Evidently this behavior is negative phototaxis.

Holmes (15) has devised two types of experiments for analyzing phototactic responses. In the first type, a glass jar, the sides of which were lined with opaque white paper, was covered with an opaque white cone, the apex of which covered an electric light bulb. An insect, one eye of which had been blinded, was placed in a circular dish in the center of the floor of this jar and stimulated to activity by jarring the container. By means of a small peep hole, every movement could be watched. Under all conditions this insect was exposed to diffused light of uniform intensity. Dissimilar species behaved differently. Several beetles, of three species, turned towards the blackened eye; a Jerusalem cricket invariably rotated toward the left; two specimens of a tachina fly and a specimen of *Eristalis tenax* made circus movements toward the normal eye. In the second type, a light-running turntable was constructed out of cardboard. An insect was so held that its feet touched the cardboard and its head faced either the center or the periphery of the turntable. A bright light was then placed on either side. Any attempt on the part of the insect to turn either towards or away from the light would cause the table to rotate in the opposite direction. When the light was on its left, the cabbage butterfly rotated the table toward the right; when the light was on the right, it rotated the table toward the left. Similar results were obtained with several other species of insects. These experiments caused Holmes to conclude: "It is not possible, we believe, to construe phototaxis entirely in terms of differential sensibility. Responses to the shock of transition, whether in the direction of an increase or a decrease of stimulation, may play a part in the orientation of many forms; but the continuous stimulating influence of light appears to be, in several cases at least, a factor of major importance."

Riley (18) finds that young toads respond negatively to the light from a 10,000 candlemeter projection lantern, and that the response is prompt and definite; but to a 16 candlemeter light, to diffuse daylight and to sunlight they respond positively. He thinks it probable that both light intensity and ray direction are factors in these photic responses.

Rheotropism.—By means of artificially induced circular currents Gee (12) has demonstrated that the leech is positively rheotactic.

Allee (1, 2) has experimentally proven that the sign of the rheotactic responses of the common *Asellus* varies with the efficiency of the response of the animal; the higher the efficiency, the greater the number of positive responses. During molting, there are no rheotactic responses. In conjunction with Tashiro (3), this same investigator has demonstrated that the rheotactic reaction is an expression of the relative metabolic activity of the animal under the conditions to which it is acclimated for the time being.

Thigmotropism.—According to Gee (12), it is positive thigmotropism which causes leeches to collect under stones and to gather in groups.

Feeding and Hunting Instincts

Hargitt (14) informs us that the tree toads (*Hyla versicolor* and *H. arborea*), which attack none but moving objects, never stalk their prey, but leap upon it from ambush. They seem to be far-sighted; for, although a tree toad will leap upon insects several feet away, similar insects may run over its legs and body without invoking a response.

Breed (7) deprived newly hatched incubator chicks of water for several days and then placed before them, in a watch glass resting on a piece of white paper, some bubble-free clear water. Particles of food were scattered over the paper. At first the chicks did not react to the water; but gave the drinking reaction to a variety of objects before drink of any sort had touched their mouths. Chicks left to develop naturally in the presence of water and food, usually found the water by fortuitous pecking or by forming drinking movements in imitation of others. These and other experiments, a description of which is omitted on account of limited space, caused Breed to conclude: (1) "Drinking usually does begin as a result of contact stimulation mediated by the prior activity of the pecking and imitating instincts." (2) "Experiments show clearly that the drinking instinct is self-independent in so far as its relation to these other instincts is concerned." (3) "The drinking instinct does not, therefore, have to be supplemented by imitation, accident, intelligence, instruction, etc., in order to act."

According to the same investigator, the pecking instinct of chicks is very imperfect at birth; but it improves rapidly in accuracy. In his first conclusion he is in harmony with both Morgan

and Thorndike; in the latter he is in agreement with Morgan and opposed to Thorndike.

Shepard and Breed (**22**) confined newly hatched incubator chicks in a dark-room for from three to six days. At stated intervals they were given water, by means of a pipette, and food was placed in their mouths. These chicks, which had had no opportunity to develop the pecking reaction, were placed on a table which had been especially designed for pecking experiments. The first attempts at pecking were indifferent and very inaccurate; but after a chick had once swallowed a grain energetic pecking followed, and improvement in accuracy was exceptionally rapid. This caused these investigators to assert that Spalding's statement of the accuracy of the first pecking reactions of chicks, the pecking instinct of which had been deferred, is an exaggeration.

Beebe (**4**) cites two interesting cases of birds securing food by using tools. In Africa a raven secures the contents of ostrich eggs by dropping stones upon the eggs; in Australia the black-breasted buzzard breaks a hole in an emu egg by dropping a stone upon it. Into this hole the bird inserts its foot and carries the egg off to its nest.

Homing Instinct

On the side of a road, Cornetz (**9**) discovered a nest of an ant of the genus *Myrmecocystus*. On a support, about five meters from the nest, he placed some sugar as a bait. The nest, the bait, and the intermediate territory were in the sunlight. About 75 meters away was an enclosed yard in which no *Myrmecocysti* had been seen that year. The roof of a shed and a high wall cast a dense shadow upon the yard. Since the shed was open on the west and north, the sun, which was in the southwest, illuminated the ground under the shed. In the open, the brightest part of the sky was in the southwest; in this yard, the brightest portion of the sky was towards the northwest. While a foraging ant was on the bait, the support was transported to the enclosure just described. On descending from the bait, the ant found herself in a strange environment. Twelve ants were used. Each hesitated more or less, each made several random movements, and then moved off in the direction that the nest lay from the original position of the bait. Cornetz thinks this proves his contention that ants are guided home by an internal factor that is derived from neither visual, olfactory, nor tactile stimuli.

Prior to the publication of the above paper, Santschi (21) published an article supporting a different view. He found that covering ants with an opaque screen affected their orientation; but that covering them with a glass plate did not. This, he thinks, militates against Cornetz's contention for an internal guiding mechanism. He believes that ants orient themselves, when placed in a shadow, by utilizing distant reference points. On account of the peculiar structure of its eye, points on the sky which have a similar blue color to us may be quite unlike to the ant. He thinks that ants utilize as reference data even the stars, and that they associate the position of the sun with the time of day.[1]

Parental Instinct

Gee (12) is convinced that leeches do not exhibit a parental instinct, because, if you separate the attached eggs from the body of a leech it pays no more attention to the eggs, even though it happens to rub against them.

By careful observations, Stevens (23) finds that the spider crab (*Oregonia gracilis*) does actually "plant out" algæ, etc., upon its body; but that it does not "plant out" sponges. Triton eggs are the only animal products "planted out."

Hartmann (13) finds that the potter wasp, *Eumenes belfragei* Cress., obtains the mud for its nest by moistening a clod with fluid from its mouth and then biting out a piece. It returns to the same clod for all of the dirt needed.

Bénard (5) discovered a large dung beetle (*Scarabaeus sacre* L.) rolling a ball about the size of a small apple. With pieces of tile, Bénard constructed a tight enclosure and placed the beetle and her ball therein. The beetle seemed to lose interest in the ball. She was then placed outside of the enclosure. After starting to run away, she halted and then returned. After trying in vain to scale the tile, she reached her ball by tunneling beneath the wall.

Wheeler (27) describes a wasp (*Aphilanthops frigidus*, F. Smith) which, in behavior, is intermediate between those wasps which lay their eggs in well provisioned nests and desert them and *Bembex*, which busies herself collecting flies and feeding them to her rapidly growing young. This wasp collects winged queen ants of the genus *Formica*, on their nuptial flight, and stores them away in subter-

[1] Those interested in the homing of ants will find an axcellent resumé in a recent paper by Santschi (20).

ranean cells. Later she lays an egg in a separate cell. When the egg has hatched, she feeds the larva with pieces of the stored ants.

Craig (**10**) has demonstrated that the egg-laying instinct of the ring-dove may be aroused by the courting behavior of the male, by the preening of her head and neck by a human being, or by the abnormal mating behavior of another female.

Mating Instincts

F. R. Lillie and Just (**16**) find that the sexual forms of *Nereis limbata* swarm on the dark of the moon; but are not in evidence on the light of the moon.

Anna Morgan (**17**) discusses the mating of the May fly, *Baetis*.

By rearing four male birds in isolation, Craig (**11**) discovered that: (1) The various notes uttered by the species and all accompanying expressive movements, including the sexual responses of the male, developed perfectly in those isolated individuals; proving that young doves do not need to learn the sounds or gestures of their species. In their motor aspects, the vocal and gesture reactions are completely and definitely fixed by the ultimate organization of the nervous system. (2) On the other hand, the innate sensory inlets to these reactions must be very indefinite and flexible; for the doves gave their cries to a large variety of objects. They made their social cries, and even their mating behavior to the human hand. (3) The object to which the doves direct their social behavior becomes a symbol, or a fetich to which they cling tenaciously, and to which they attach a great complex of reactions. In all four cases the human being became such a symbol.

Miscellaneous Instincts

Bénard (**5**) noticed a line of beetles approach the charred remains of a former fire. Each selected a bit of wood of its shape and color and clung quietly to its shaded side.

Hibernation.—Hargitt (**14**) states that the hibernation of the tree toad is similar to that of other amphibians. In a warm laboratory the toads show no tendency to hibernate.

Riley (**18**) found that handling with undue pressure and roughness, or placing them on the back and holding them in that position for a few minutes causes young toads to letisimulate.

According to current theories, migrating birds flock for one or all of the following reasons: (1) to secure companionship; (2) to

profit by the experience of the older birds; (3) for the protection that large numbers afford. Trowbridge (**25**) dissertates that these theories ignore two important factors; (1) a large flock, by virtue of its numbers, automatically maintains the right direction; (2) in the case of large birds, the mode of arrangement is an automatic protection against enemies.

The following quotation shows that Robertson (**19**) believes that the entomophilous flora is better pollinated where some of the bees are oligotropic than where all are polytropic. "My view is that the bee fauna is all that the flora will support, but that there is constant competition between bees, and that natural selection favors those which are the most diversified; *i. e.*, the least competitive in their food habits." Speaking of the Andrenidae and the Panurgidæ, he writes: "The early maximum, the short flight, the non-competitive phenological distribution, and the frequently oligotropic habits indicate that these bees have managed to hold their own by dividing up the remaining field and occupying the most favorable corners left by their parental polytropic competitors."

Savagery.—By well-planned experiments with wild rats, tame rats and two generations of hybrids, Yerkes (**28**) has demonstrated that savagness, wildness and timidity are heritable behavior complexes and hence instincts.

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SENSATION AND SENSORY DISCRIMINATION IN ANIMALS

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The greater part of the literature of the year concerns vision but there are two papers on sound which may be mentioned. Parker (37) thinks fishes hear and that such sounds as reach fishes not only influence their movements but also the direction of their movements. His stimulus was an iron ball pendulum weighing

4,300 gr. which struck the exact middle of an end of an experiment tank with a momentum of 361,200 C.G.S. units and produced a low booming noise. The reviewer questions whether this is proof of sound sensitivity. Peter (**39**), from two years' observation of butterflies, has come to believe that there is a possibility of hearing in these insects. At least, the females hear the "*knacken*" of the males.

The relation between common chemical sensitivity and taste has been made the object of an experimental study by Parker (**38**) who agrees with some others that chemical sensitivity is a function of the spinal nerves.

In the line of food reactions, Hadley (**22**) offers an additional note to his previous work on the food reactions of young lobsters. Reese (**41**) uses another form, the spotted newt. He thinks that it employs both sight and olfaction in securing food but that the latter is the more important. Copeland (**8**), from a study of the same animal, believes that the approach to an object is a visual response, but that the nosing of an object is an attempt to test its edibility by the sense of smell and that the snapping at a stationary object depends upon olfactory stimulation from substances in solution. He concludes that vision functions in the following of a moving object whereas food located through vision is afterward recognized as such by smell. The reactions of the puffer or swell-fish (**7**) to concealed food cease when the olfactory apparatus becomes inoperative and such behavior is only seen when the organs again become functional.

The first article on vision which will be mentioned is a study of adaptation by means of the pupil-motor reflex in the eyes of owls (**33**). Light from a Nernst lamp, passing through a variable and easily controlled opening, was filtered through colored gelatine plates. Owls kept long in the dark upon being tested with very weak light showed a strength of motor reflex which varied as follows from strong to weak: YG, G, GB, R and O, BR. The valence was practically the same as that of the investigators. There was also no essential difference under bright adaptation. Owls' eyes do undergo adaptation changes and show the Purkinje phenomena. Tested with different intensities under dark adaptation they show a real increase in pupil-motor excitability inasmuch as the absolute threshold lies much lower. The authors think that the difference between rod and cone vision is not so great as has previously been supposed.

Bingham (4) studied the perception of size and form in another bird using the Yerkes-Watson apparatus. It will be remembered that with this apparatus not only the brightness but also the size, form and relative position of the stimulus areas can be independently varied and controlled. The two complex stimuli employed by Bingham were changed little by little until the only distinction was that of size. Under these conditions the birds learned to discriminate circles whose diameter differed from the standard 6 cm. by $\frac{1}{4}$ to $\frac{1}{8}$. The form tests were completed with but one bird. This bird learned to discriminate between a triangle and a circle but the habit broke down when the triangle was inverted or circumscribed by the circle. The conclusion was drawn that the discrimination was made on some other basis than that of form and probably depended upon the unequal stimulation of different parts of the retina. Quite in a line with this work Hunter (31) argues that animals do not perceive forms but patterns, *i. e.*, the form stimulus against a background, that pure form perception is a later and more abstract thing. He insists that the outlined field against which the form to be discriminated is set must be varied in order to prove form discrimination.

The main work of the year, however, seems to have been in the realm of color vision. The Watsons (48), with the apparatus mentioned above, undertook some experimentation with rodents designed to prove whether, in the use of color, the differential response is made on the basis of wave-length. Two rats were trained to react positively to R when the alternative color was G. When the relative intensity was varied or one color was cut out altogether it was found that the animals were reacting to G and that the R had no stimulus value whatever. Animals trained for B and Y failed to perfect the discrimination when both stimuli were present at full intensity. B light evidently had a much higher stimulating power than Y. They conclude that the long wave lengths offer a very slight stimulus to rodents and that they have good if not conclusive proof that the response was made to differences in intensity.

Babák (1), who had previously used the breathing reactions of frogs to study the temperature sensitivity, in his latest work employs the same method to investigate their sensitivity to color. He finds that the stimulating effect of V is extraordinarily great even in weak intensities while R gives a result exactly opposite.

There are three articles on the color sense of bees which may be

mentioned. Von Frisch (**19**) worked in the open air and in the sunlight. He trained bees to come to strips of yellow paper. After two days' training he put the Y papers among 30 grades of gray papers of the same size. There was sweetened water on the papers of the same brightness. The bees chose the Y. The investigator thinks, therefore, that they must see color. He obtained the same results with B but the bees could not be trained for R and confused RV and B as well as dark R and dark gray. Hess (**26**) criticizes this work, saying that the odor of the paper itself or that acquired through handling was not excluded. He asks also, how von Frisch knew that the bees which came the third day were the trained bees or how he knew that the bees which came later on a particular day were not attracted by the presence on the paper of those which came first and not by the color. Hess made some similar experiments but caught and carefully marked the bees which came to the particular color, the first days, and in the concluding tests found no evidence of training. In spectral lights he finds that the bees congregate in the area which appears brightest to color-blind men. Lovell (**34**), after a long series of experiments with honey bees, says: "Any surface whether it is bright or dull colored on which there is nectar or honey will be freely visited by bees for stores after these liquids have once been discovered but they will not be discovered as quickly on a surface which does not contrast in hue with its surroundings as on one which does so contrast." "When honey bees are given the choice between a conspicuous and an inconspicuous object under similar conditions they exhibit a preference for the former."

In connection with the work of von Frisch, Mrs. Franklin (**12**) suggested that these results indicated a dichromatic color sense and asked that he try with his bees a BG paper, the complementary of his R. He did so and found a completely non-chromatic region for the bees in this part of the color spectrum. According to von Frisch, then, the bees see only Y and B and are RG blind. Mrs. Franklin shows how this is related to her color theory.

Hess (**25**, **27**) and von Frisch (**15**, **16**, **17**, **18**, **20**), in a number of papers, continue their controversy over the color sense of fishes. Each reports some new experimentation and each clings to his previous opinion. Von Frisch thinks that fishes have a color vision as proved by color adaptations, *Hochzeitkleid* and feeding experiments with colored food. Hess insists that the vision of fishes is like that of a totally color-blind man. He argues that the facts of

color changes do not prove that fish perceive such color differences. These may be protective devices against carnivora, birds, etc. He points out the fact that fishes which spawn at great depths where all colors would appear as gray have highly ornamental patterns and concludes from his feeding experiments that the choice of food is made on a basis of brightness. Von Frisch used histological methods, sectioning of nerves, and other experimental procedure as foundation for his statement that the expansion of pigment cells is, within limits, independent of the brightness of the bottom on which the fish rests and depends alone on color value. Neither of these men controlled the intensity factor. Ewald (**10**) criticizes some of the conclusions of Hess. Hess reasons that if the curve for the stimulus value of spectral lights is the same for apes and man, for fish and color-blind men, the vision must be similar. Ewald says the proof is worthless, for eyeless shell-fish show the same reactions in spectral light. He also quotes from Magnus who says that the curve for the stimulus value of the iris sphincter in fish is normal even when it has no connection with the eye. The fact that photographic plates react differently to different ends of the spectrum is also mentioned in illustration of the weakness of Hess's proof. Color adaptations were also found by Stevens (**45**) in crabs. While studying the decorating instinct in crabs he suspended some crabs in pails the insides and bottoms of which had been painted with different colors. He reports that, under such conditions, the color reactions were markedly influenced by the color to which the animal had previously been exposed. He concluded, however, that the coëxistence of this specific chromatism with the decorating instinct is merely accidental and not causal.

Now we come to some articles dealing more or less with tropisms and the greater part of these concerns phototropism. Riley (**42**) studied the light reactions of young toads, Gross (**21**), arthropods including diptera, lepidoptera and orthoptera. Gross used the Laurens apparatus for monochromatic light with Boys' radiomicrometer to measure and equate the intensities of the colored lights. He gives the wave lengths employed. He concludes: "The relative stimulating efficiency of the rays of any part of the spectrum is independent of intensity and is not the same for all animals nor for the different ages of the same animal. The more refractive rays of the spectrum are not always the most effective in stimulating an organism. Prof. Holmes (**29**) noted the similarity between the behavior of *Bombilius* and the mourning-cloak

and other butterflies which are usually positively phototactic but when resting on the ground in the sunlight or hovering in the air assume a negative orientation.

A few of the papers deal more with the analysis of the response itself than with the proof of the response. Holmes (**28**) in a very interesting paper reports a study of the coordination of the activities of the tube feet and the spines of the sea urchin in movements toward or away from light. He shows that phototactic movements like those away from a mechanical stimulus depend upon the correlated activity of various organs of locomotion. Franz s (**14**) interest in aquatic migrations led him to examine those daily movements said to be due to phototaxis. He prefers to make his studies in free open life. From such observation of mollusks, echinoderms, insects and amphibians he asserts that the most frequently observed phenomena of phototaxis are of two kinds: (*a*) swarming movements of larval plankton up to fresh water, and (*b*) flight movements occasioned by cramped or confined quarters. He has never convinced himself of daily migration periods and thinks the evidence for this has been drawn from artificial and unnatural conditions.

Ewald (**9**), in a long series of experiments, examines the ways in which light reactions can be artificially modified. The effect of caffein, strychnin and atrophine was observed by Moore (**30**). Brundin (**6**) compared the reactions of two terrestrial amphipods one of which was positively phototropic, the other negative. It was found that heat and dryness favor the positive reactions and cold, moisture and quiet the negative. In other words they were fostered by their native environmental conditions.

Besides these studies on light reactions there are a number which have to do with other fields which will be mentioned briefly. MacCurdy (**35**) experimented with the acid and alkali relations of starfish in the light and dark respectively. The careful work which Vieweger (**47**) reports is divided into three parts: (*a*) a study of chemotaxis in paramoecium, (*b*) the motor responses of colphidium, (*c*) the effect of salts on taxis. Fasten (**13**) gives a study of a parasitic copepod of the brook trout. Bohn (**5**) found that in some copepods he could vary the sign of both geotropism and phototropism by pressure. Transehe (**46**) gives the curve for Daphnids of a day's adaptation to temperature. He says that the adaptation can be clearly seen after seven hours. Hutchinson (**32**) finds that in the protozoa examined each has a resistance to heat peculiarly

its own which under given conditions is quite constant. Pringsheim (40) makes an interesting comparison of the reactions of bacteria and the spermatozoa of ferns. Shelford (43, 44) from some prolonged experiments concludes that certain animals studied react to evaporation whether it is produced by movement, dryness or heat and that fishes react clearly to varying amounts of carbon dioxide, acids and to boiled water. Baunacke (3) says, concerning statocysts, that there are statical organs which have as their chief function the maintenance of equilibrium and there are others which release definite directive movements. From a study of the house snail, he thinks that there are statocysts which are centers for the righting reflexes and that the sinking of the head of the snail, in a positive direction, preparatory to righting, may be regarded as a reflex which is released by the free position of the planarian which excludes foot contact and reflex inhibition.

There are still a few contributions to mention and these deal more or less exclusively with the laws or principles of tropisms. Bancroft (2) defends Loeb's position of compulsory orientation as against Jennings's theory of trial and error. He makes Euglena, Jennings's own form, the object of his study. He gives a most careful analysis of the light reactions of this plant and concludes that the heliotropic mechanism and the mechanism for motor reactions are independent variables and can be modified independently. Holmes (36) from some ingenious experiments with butterflies comes to the conclusion that it is not possible to explain phototaxis entirely in terms of differential sensibility—the continuous stimulating effect of light appears to be the major factor.

Loeb is responsible for the statement that the light reactions of animals should follow the law of Bunsen and Roscoe—the effect should be proportional to the product of the intensity and the time. It has been said that animals do not follow this law but that the effect is proportional to changes of intensity only, *i. e.*, the amount of change per unit of time. Ewald (11) attacked this problem using as his object the eye movements of *Daphnia*. It has eye movements unusually well fitted for this purpose. The animal was placed under a microscope and conditions were so arranged, by means of diaphrams of different sizes and revolving sectors, that different light intensities could be combined with different times of exposure. Under these conditions it was found that for the eye movements of *Daphnia* the energy law holds within the limits of the experiment.

The Henris (**23**, **24**) worked on the eye movements of cyclops under ultra-violet rays. They found that there exists a physiological excitability to these rays; that this can be studied with all the precision that excitability to electricity, retinal light, touch, and sound can be studied. The photo-excitability obeys the law of threshold, of minimum energy and of physiological induction. In the later work the same object and the same method was used to investigate Weber's Law and that of Jost.

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HABIT FORMATION, IMITATION AND HIGHER MENTAL PROCESSES OF ANIMALS

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The first part of Johnson's monograph (7) is devoted to a thorough and critical review of the work on pitch discrimination in the dog. The results of Pavloff and Selionyi, on the saliva-reflex, that of Goltz, Munk, Kalischer, Rothmann and Swift on the effects of removal of the temporal lobes, inferior corpora quadrigemina and one or both cochlea leave the problems in an unsatisfactory state. All have used very crude behavior tests a fact which explains their widely divergent conclusions. The results of Johnson's experiments make up the second part of the monograph. He found that in from 6 to 44 days two female mongrel dogs, sisters, nearly four years old, learned to make the discriminations required in the following problems: (1) Discrimination between two tones, middle C (256 d. v.) and A above (384 d. v.), sounded on tuning forks struck by hand. (2) Discrimination between the two tones sounded on blown variators. (3) Discrimination between the two tones sounded on forks and on large and small variators indifferently. (4) Discrimination between chords containing one and the other stimulus tones respectively.

To the deeper tone the animals were required to place the fore-feet on a chair at the operator's left; to the higher one to mount a low box at the operator's right. In the case of an incorrect choice the animal was not fed. About two days after birth the edges of

the lids of the eyes of both these dogs had been scarified and sewed together, thus assuring the continuance of temporary blindness. The results of these tests agree well with those of Kalischer and Rothmann.

Sixty days after learning the last problem each dog acted without error.

In another series of tests, 505 for each dog, in which experimenter, assistant, and stimulus-tone were outside the room in which the animal was placed when the tone was struck and in which she made her choice, there was little evidence of discrimination. They so behaved as to indicate that lack of attention and not inability to discriminate may be the explanation of their continued failure.

A stimulus-cage was constructed and electrically driven forks were used with König resonators to insure a practically pure tone-stimulus, non-localizable by the human subject, and almost free from accessory noise, overtones and partials. Considerable difficulty was had for some three weeks to accustom the four dogs (two other younger females now being used) to the electric shock which was the punishment received when they turned into the wrong pathway. The problem was not learned in ninety days nor was there any sign of improvement. Thinking that the two tones might be too nearly alike, the problem of associating a tone C (256 d. v.) with food in F and release without a stimulus-tone food in F′ was given; but the results in ten days (150 trials) were negative. It is an interesting fact that these four dogs in from 9 to 12 days did discriminate two noises made by two electric buzzers. Except in the case of dog 3 they learned in about the same time to discriminate the noises when the buzzers had been interchanged in position. Position-habits were to be observed in most of the experiments.

The second part of the investigation was devoted to a comparison of the learning-time and learning-methods in blind and normal dogs. Six different puzzle-boxes were used, each with a different latch. Four more dogs were used in these tests making eight in all. The blind dogs had learned to behave ordinarily as normal, although none of their world was visual. How would they differ from normal dogs? Dogs 7 and 8 were also made blind in the same way as described for 1 and 2. The data gathered show that the dog is capable of learning to make complex adjustments and a large number of instinctive movements without the aid of vision.

No dog lost more than ten per cent. in accuracy after a sixty-day interval. Control tests in total darkness gave results which indicate that the light had some stimulating effect on both blind and normal dogs. The other control test was to turn the box through 90° from its original position, the first change setting practically a new problem for the animal. Other turns of 90° disturb them less. This study shows that it is impracticable to attack the "Molyneux problem" by using dogs rendered temporarily blind. Tests on the blind dogs after their eyes were operated on to restore their sight and on normal dogs with rope and disoriented box suggest as to the experiments proper that even normal dogs may make little use of vision. They probably rely largely on kinæsthetic and muscular sense-processes. Given ten trials a day fewer days were required for learning than if twenty trials were given. Fatigue, monotony, and consequent lack of attention and effort are the probable explanations.

The experiments of Szymanski (15) were made to determine if dogs (fox terriers) and cats can discriminate the different positions of the sounds made by an electric buzzer and learn to go for food only to the place at which the sound is made. Odors were eliminated as possible stimuli. The results were negative, the chief reason assigned being the small size of the room. Place-habits were marked in both dogs and cats though broken in the latter in two weeks. Preliminary habits indicated influence of having been fed previously by the experimenter. In these animals as in the white rats and in fish the past behavior is a large factor in present reactions. There are two stages in learning: the negative or partial loss of habit or inborn connection which are directly opposed to the new and growing habit; the positive or completion of the new and loss of the old. In tests without the sound stimulus but with change of distance and direction of food-box it seems to be indicated that there are two types in dogs; one motor, the other visual. Cats seem to be visual. The suggested explanation is that the former are animals of chase, the latter lie in wait.

The study of Sackett (12) is a definite attempt to combine the experimental and the natural history methods. In all 16 porcupines were used, natural conditions being obtained by out-door caves, dark dens, and natural food. Frequent journeys to the woods were made in order to observe their natural behavior. These animals are nocturnal and show little tendency to hibernate. When born the young are well developed even to the quills. If they

play it is only while very young. Even the adults are easily tamed, eating out of the experimenter's hands one day after capture. They never thiow their quills. They make excellent subjects for experimental study. When offered food they first try to grasp it with the mouth. If this is prevented they readily grasp with the hand. In 12 out of 14 series of tests they used the right hand if the experimenter used his and similarly with the left. This is evidence that this animal is neither right nor left handed. The habit of taking food with one hand is very readily and thoroughly broken. To re-establish this old habit is almost as difficult as its initial formation. They are readily trained to respond to one kind of food with one hand, to another kind with the other hand. They can change the hand as often as the kind of food is changed. Brightness is the probable stimulus, cubes of sweet potato and carrot or cabbage being the foods used.

They learn to operate puzzle-boxes with four locks in a series. The results with this apparatus as in all other experiments demonstrate that in ability to discriminate and learn the porcupine is practically on the same level as the raccoon and the monkey. Unsuccessful attempts were made to determine the porcupine's ability to discriminate tones of different pitch. The cochlea is complex and the sounds made by the animal itself cover a wide range. The forms used were made with the denning proclivities of the animal in mind. There was some evidence that but part of the form was the basis of discrimination which was probably kinæsthetic as well as visual. The brightness discrimination is about 10 shades of the Nendel series. It may be finer than this for the grays at the ends of the series. They probably can not discriminate color when tests are made with colored papers. No account of the area of acute vision has been found in the literature. Rotation of the maze 90° and later another 90° was a source of confusion to the animals though less following repeated rotation. After once learning the maze they were able to follow it in the dark. Learning it in darkness differed little from learning in daylight. Memory tests after a 100-day interval show little if any loss of ability. Tests in which there is more of the kinæsthetic in relation to the visual show better retention.

After verifying Graber's investigations, which proved that cockroaches avoid light and seek the dark Szymanski (13) sought to so modify by the punishment method the responses that these insects would seek the light and avoid the dark. The strength of shock

to be used was first carefully determined in preliminary trials. The insects used were male larvæ about one and a half years old, the apparatus being cleansed after each series of tests.

As the insect entered the dark end of the box the current was turned on, as it retreated to the light end the current was turned off. Learning was considered complete when the insect, being in the light, turned back to light ten times on the boundary line, without receiving a shock. The time required for training with all of the ten animals except nos. 3 and 5 was on the average from three quarters to one hour. These two suffered from such great fatigue that their training could not be completed in one day. The analysis of the results and curves gives two factors, *practice* and *fatigue* hence a special case of Kraepelin's "Arbeitscurve." In the length of time during which they retained this new habit they show marked individual differences. There is no evident relation of permanency of this new habit and the number of shocks required to establish it. The training is evident in their behavior for only a short time but they relearn the habit after only a few shocks. It is possible to establish the habit in an insect with the antennæ removed. These results do not support the statements of F. Plateau concerning bumble-bees and other insects.

A brief account of the same results is given in a second article by the author (14).

The purpose of the paper by Gregg and McPheeters (3) is critical. Cole's "card-displayer" apparatus was duplicated and experiments repeated but with the experimenters hidden by a screen and in the control series the color cards were removed and the levers used alone, the levers were so operated that they were not visible to the animals but still made their usual sound. A series of two sounds invariably called out the normal response in the raccoon. Four and five sounds were given and the results enable the authors to state that any completed series of sounds is the sensory stimulus. The two raccoons used may have and use images. The results obtained under the ingenious controls strongly suggest that the "stimulus-response" type of behavior is the only one exhibited by Cole's raccoons as well as by the two subjects of the present experiments.

The brief paper by Lashley (8) is a record of incomplete observations and experiments on a large Amazon (*Chrysotis* sp.) parrot imported in 1892 and which had learned to speak about 60 words some of which were combined into phrases. He made a number of

inarticulate sounds distinguishable from instinctive notes. These are given most often in response to a visual or auditory stimulus, more frequently the latter. These inarticulate sounds—"singing, whistling, barking, mewing, cuckling, and coughing"—offer the best material for experiment because of their wide qualitative range and they are given in response to auditory stimulation. In two series of experiments on timbre and one on pitch it was found that the bird distinguishes and reproduces the musical tones and the pitch of the stimulus. There was no evidence of imitation of two or more successive tones. Capacity for circular imitation may be developed largely by conditions of captivity. The impulse to imitate is probably connected with the sexual life.

Lashley and Watson (9) have reported notes regarding the physical and mental development of a monkey. The subject of these observations was a young *Macacus rhesus* monkey conceived and born in captivity. At birth the little monkey was far advanced physically. In sensory-motor development it was far superior to the human infant and the rate of development during the first fifteen weeks (the period observed) was remarkably rapid.

From general observations of the orangs and chimpanzees Haggerty (6) came to question the adequacy of the "sense-impulse" theory of animal learning. The animals experimented on were two strong, docile, female orangs and a quick nervous male chimpanzee. Betty at once and Nancy after some looking at the apparatus used in the best possible way a stick with a hook on the end to secure food which was on a table outside the cage and beyond their reach. Baldy made no effort to use the stick. Betty used a stick to get food from inside a pipe. Baldy failed in this also and showed no signs of imitating the successful behavior of the others. Nancy repeated the behavior of Betty in the pipe experiment in such a way as to lead the experimenter to conclude that she gave certain evidence of "inferential imitative behavior." With both orangs he obtained results which indicated that, though there is some use of the "trial and error" method there is also something above the mere sense-experience level, that is, a low order of rationality. One can not but wonder as to the previous experience of these animals in its bearing on the solution of the present problems.

The horses of Elberfeld continue to attract attention. Claparède (2) returned to Elberfeld for three days for new observations and to make the crucial test of putting to the horses numbers and problems on cards drawn at random and unknown to any one

present. It was found that of all the horses—Hans, Zarif, Muhamed, Hänschen, and blind Berto, the last made fewer mistakes than any other even when the assistant was not near him. There were mistakes both when the questioner knew the answer and when he did not. Since Claparède's first article in vol. 12 of the same *Archives* many others have appeared. A large part of his present paper is devoted to review and criticism. Fraud and trickery are dismissed as impossible as are also unconscious visual, auditory, or tactual signals. Some believe that the horses work out the answers to problems in cube root by themselves. Chance is ruled out and there are too many problems solved for memory to be the explanation.

The "protest" from Germany is dogmatic, unscientific, negative, unsympathetic. Instead of "protest" get other horses and investigate. Then refute. A letter by Dr. J. de Modzelewski is published in which he tries to refute all explanations except that of telepathy. He gives as the percentages of right answers in four series of tests with Zarif, Muhamed, Berto, and Hänschen, 11 per cent., 13 per cent., $7\frac{1}{2}$ per cent., and 11 per cent. One is, however, not convinced when he says telepathy explains it all. Professor Claparède concludes in favor of a process of thinking peculiar to these animals, the full proof for which has not yet been given.

Haenel (4) was present in experiments with the Elberfeld horses when the halter was no longer used by the trainer. He could see no signals. Other visitors could see none, particularly in the work of Krall, and the horses replied correctly. The gradual increase in the number of right answers, the changing mood of the horses, the types of mistakes, such as confusing units and tens, the phonetic spelling and consonant, ungrammatical method of expression, answers opposed to suggestion and expectation, and the exclusion of all mechanical and mental helps are conclusive proofs to Haenel that the horses "think."

The dog, Rolfe, whose performances are reported by Mackenzie (10) has been trained to reply to questions by tapping the floor with his foot, 11 times for G, 14 times for K, etc. The trainer is a woman of very delicate and artistic temperament and a semi-invalid. Other dogs and a cat have also been educated as "Rolfe" has. Of himself Rolfe began to make combinations which his trainer decided stood for letters. He never makes any errors and uses the patois of the Mannheim peasants and the smallest numbers for letters in most frequent use. He is said to have a system of

stenography as do the horses—s-n is essen. Vowels are often omitted. Not only is he said to know grammar but he can give sentences to illustrate rules. He is very easily fatigued.

At three separate times but with the trainer present the author tried the dog with pictures on cards which were drawn from envelopes so that no person, not even himself, could see. The dog after rapping 4, "tired," spelled "Rot, blau, Eck" which was correct. As many as ten resemblances between Rolfe and the Elberfeld horses are pointed out. The author rather characteristically closes his article with a plea for the return to the old dual conception of mind as reason and intuition. The order of increasing reason may be horse, dog, man, but the reverse for intuition.

Larguier des Bancels and Claparède succeeded in holding a single session with "Rolfe." From a series of cards previously prepared one was chosen and shown to the dog in such a way that the trainer or assistants probably could not see the picture on the card. After considerable reluctance the dog spelled out the words which described fairly well the pictured objects. The dog's illness prevented them from submitting him to more rigid tests on the following day. The question of his spontaneous use of speech thus remains unsolved.

Parker (11) discusses the subject of adaptation in relation to intelligence. No feature of organic life has received greater emphasis than adaptation. We are just learning that to think of an organism as a machine standing still is to divest it of that which is most distinctive. Adaptation is an essential of dynamic activity. But this activity which is continuous determines the adaptations. Classed alone adaptations have been unduly emphasized. Many reactions have been called adaptations which are not. Animal reactions, the author believes, are in the main free from adaptive restraint. They depend upon the fluctuating momentary conditions of the animal body. They are adaptive only in main outlines. If we attempt to explain this condition by assuming something like intelligence we are arguing in a circle, for intelligence is our own name for our own chief means of adaptation.

Burroughs's article (1) is written in criticism of the study of animal behavior in the laboratory as set forth in an earlier paper by Professor Haggerty.[1] In such study animals are drilled into forming new habits, the reasons for which they do not understand. Intelligence, strangely used by Mr. Burroughs, is, for the most part,

[1] *Atlantic Monthly*, May, 1913.

conspicuously lacking. The gulf between the mind of man and of animals is so great that he believes it is misleading to describe so-called animal psychology in terms of human psychology. The reason the laboratory student finds so little of "intelligence" in animals is that the problems he sets are human problems, the situations are so foreign to the animals. His use of the word intelligence is yet more strange when he says that plants show it in the devices for scattering seed, securing cross-fertilization, etc. The laboratory student has animal behavior in a nut-shell and is therefore without perspective. If an exact science of animal behavior is possible then the laboratory student has the advantage; yet such is an impossibility in the laboratory or out of it.

Those animals that are self-armed, like the porcupine, Burroughs asserts, are slow and dull of wit. The reviewer is here constrained to ask the author to examine the results obtained by Dr. Sackett on the porcupine, the review of which will be found above.

The experimentalists should prove or disprove that birds are color-blind and other like problems because such would furnish a crucial test of such large questions as Darwin's natural selection theory. He wishes that the experimentalists would determine what is the sense which enables one bird to pursue another so unerringly and how gregarious birds fly as a unit. The human experiences which we call telepathy are the survivals of this lost human capacity. He closes his discussion by saying that there is little or no value in such investigations as that of the tactual sensations of the white rat unless they yield the key to some larger problem.

Mr. Burroughs will find it difficult to justify his use of the term intelligence. He assumes that telepathy is a proven fact in human psychology and is I believe in error in his facts or interpretations concerning porcupines and the unity of response in the aerial evolution of birds. Other explanations should be long tried before resorting to mental telepathy.

Haggerty's article (5) gives the contrary viewpoint. Like Mr. Burroughs every student of animal behavior regrets that careful experimentation requires so much time. All would like to state the whole truth about tropisms or mental evolution in one sentence. Haggerty cites the experiments by Dr. Hamilton, the results of which have been published, on eight normal human beings—men, boys and girls,—two defectives, five monkeys, sixteen dogs, five cats, and one horse, which prove that any one who believes in a

qualitative difference between the animal and human mind has a difficult task to give a satisfactory explanation of such facts. These experiments would also seem to prove that animals do not respond in an invariable manner peculiar to their species while man has the possibility of wide variation. They also show that there is much animal behavior in man and some human behavior in dogs and monkeys. For Mr. Burroughs to deny that animal behavior can ever become an exact science is a denial of all real science. The experimental method must be used just because of the complexity of nature and it is being extended to even education, religion and eugenics. On its tangible results depends our entire social organization.

The movement for the experimental study of animal behavior has been created within the past decade or so and has accomplished much. A fact has no more or less virtue for having been discovered experimentally or by an observing naturalist.

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